Strategic technology alliances: Trends and patterns since the early eighties

5. Strategic Technology Alliances: Trends and Patterns Since the Early Eighties

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1. INTRODUCTION

This chapter analyses some basic trends and patterns in inter-firm strategic technology partnering over the past two decades. The growth patterns in strategic technology partnering reveal that this phenomenon has become increasingly relevant during the period under investigation. Joint ventures, once the dominant form of partnering, have to a large extent been replaced by a wider variety of contractual agreements. International patterns in partnering are also discussed for the Triad (USA, Europe, Japan) in terms of changes in the distribution of domestic and cross-border alliances. Finally, the extent to which growth in contractual alliances complements foreign investment as a strategy for gaining access to competitive assets abroad is discussed.

2. A BACKGROUND TO R&D PARTNERSHIPS: MOTIVES, ORGANIZATIONAL SETTINGS AND SOME DEFINITIONS

Inter-firm R&D partnerships are part of a relatively large and diverse group of inter-firm relationships that lie between 'arm's length' market transactions and integration by means of mergers and acquisitions. When inter-firm relationships began to attract attention in both the economics and the business and management literature, a number of taxonomies of different modes of inter-firm relationships were introduced. Contributions such as those by Auster (1987); (Chesnais 1988) Contractor and Lorange (1988); Dussauge and Garrette (1999); Hagedoorn (1990, 1993); Narula (1999); Osborn and Baughn (1990) and Yoshino and Rangan (1995) have gradually become integrated in the literature to the extent that it now seems sufficient to outline the main forms of inter-firm relationships. Since the focus in this chapter is

particularly on R&D partnerships, we will briefly discuss the antecedents to those partnerships, one can expect to have an impact on R&D, innovation and technological development.

If the degree of organizational interdependency is used as the criterion to distinguish between different types of co-operative arrangements (see for example, Hagedoorn (1990, 1993)), one arrives at the following classification:

- Licensing refers to agreements that provide unilateral technology access, frequently through patents, to a licensee in return for a fee. Cross licensing is a bilateral form of licensing whereby companies usually swap packages of patents to avoid patent infringements or exchange existing, codified technological knowledge.
- Second-sourcing agreements regulate the transfer of technology through technical product specifications in order to produce exact copies of products. In the case of mutual second sourcing this transfer takes place between two or more companies that transfer the technical specifications of different products.
- Customer-supplier relationships are co-production contracts and co-makership relations that basically regulate long-term contracts between vertically related, but independent companies that collaborate in production and supply. A specific case of customer-supplier relationships is R&D contracts where one company is sub-contracted by another company to perform particular R&D projects.
- Joint R&D pacts and joint development agreements are contractual relationships through which companies perform jointly-funded R&D projects or, in the case of joint development agreements, jointly work on the development of new products or processes.
- Joint ventures combine the economic interests of at least two separate companies in a distinct organizational entity. Profits and losses are usually shared in accordance with the equity investments by the parent companies. Joint ventures act as separate organisations that have regular company objectives such as production, marketing and sales, but also R&D if relevant, as a specific objective of the partnership.

In this context we will refer to R&D partnerships as the specific set of inter-firm collaborations where two or more firms, which remain independent economic agents and organisations, share some of their R&D activities. Such R&D partnerships are primarily related to two of the above-mentioned categories, that is, equity-based joint ventures and contractual partnerships, such as joint R&D pacts and joint development agreements. Since both of these modes of cooperation feature prominently in the following analysis, and since they are also the (empirically) most important forms of bilateral

R&D exchanges and joint R&D undertakings, we will discuss the joint venture and contractual modalities in somewhat more detail.

Joint ventures are certainly one of the oldest modes of inter-firm partnering. Joint ventures, including those involving a specific R&D program, have become well-known during the past decades (see, Berg et al. (1982); Hagedoorn (1996); Hladik (1985)). Joint ventures are organizational units created and controlled by two or more parent companies, and as such, they increase the organizational interdependence of the parent companies. Although joint ventures can be seen as 'hybrids' that fall between markets and hierarchies, they do come close to hierarchical organizational structures as parent companies share control over the joint venture (Williamson, 1996). However, joint ventures can also act as semi-independent units that perform standard company functions such as R&D, manufacturing, sales, marketing, and so on. It is this semi-independent status that enables companies to apply joint ventures in a broader strategic setting where companies enter new markets, reposition themselves in existing markets or use exit strategies in declining markets (Harrigan, 1988).

According to Hagedoorn (1996) and Narula and Hagedoorn (1999), the empirical evidence points to a decline in the popularity of joint ventures when compared to other forms of partnering. It can be hypothesized that the decreasing popularity is probably due to the organizational costs of joint ventures together with their high observed failure rate (Kogut (1988); Porter (1987)). More specifically, problems with the continuation of joint ventures, as discussed in the literature, are related to the risk of sharing proprietary knowledge, the 'appetite for control' by one partner and a divergence of strategic objectives (Harrigan (1985, 1988); Hladik (1985)).

Recent studies have established that non-equity, contractual forms of R&D partnerships, such as joint R&D pacts and joint development agreements, have become most important modes of inter-firm collaboration as their numbers and share in the total of partnerships has far exceeded that of joint ventures (Hagedoorn (1996); Narula and Hagedoorn (1999); Osborn and Baughn (1990)). These contractual agreements cover technology and R&D sharing between two or more companies in combination with joint research or joint development projects. Such undertakings imply the sharing of resources, usually through project-based groups of engineers and scientists from each parent company. Capital investment costs, such as laboratories, office space, equipment, and so on, are shared between the partners. Although these contractual R&D partnerships have a limited time-horizon due to their project-based organization, each partnership nonetheless appears to require a relatively strong commitment from the companies involved and a corresponding level of inter-organizational interdependence during the joint

project. However, compared to joint ventures, the degree of organizational dependence between companies in an R&D partnership is still smaller, and the time-horizon of the project-based partnerships is, by definition, almost shorter (Hagedoorn, 1993).

The practical difference between the two main sub-categories of contractual R&D partnerships, that is, R&D pacts and joint development agreements, is quite small, and largely depends on the industry-specific importance of R&D. Thus in high-technology industries such as biotechnology, pharmaceuticals and information technology, these contractual arrangements are frequently focused on in-depth research activities, while in many other industries such partnerships will focus more on the development and engineering of new products or new processes rather than research.

Given the somewhat more informal nature of this form of collaboration, the R&D pacts and joint development agreements cover a wide variety of legal and organizational arrangements. Also, even more than in the case of joint ventures, these contractual R&D partnerships are to be seen as incomplete contracts,[1] since it is *a priori* impossible to specify the concrete results of the joint effort. Consequently, the causes for the popularity of contractual arrangements are to be found in the flexibility that companies achieve through entering into such relatively small-scale projects. Specifically, the costs of both intended and unintended terminations are much lower when compared to the costs of the termination of a joint venture, which involves the dissolution of a separate organization.

An interesting issue in this context is the overall motivation of companies to enter into different R&D partnerships. In general, it would appear that both a cost-economizing and a strategic rationale play a role. Cost-economizing motivation applies when at least one company enters the partnership, mainly to lower the cost of some of its R&D activities by sharing the costs with one or more other companies. The cost-economizing rationale can be expected to play a role, particularly in capital and R&D-intensive industries, such as the telecommunications equipment (capital goods) industry, where the costs of a single, large R&D project are beyond the reach of most individual companies (Hagedoorn, 1993). However, the strategic rationale becomes important when, for instance, companies decide to selectively enter into R&D partnerships that are not related to their core activities, while keeping their primary R&D activities within their own domain (Teece, 1986). The strategic intent of R&D partnerships is also apparent in those cases where companies jointly perform R&D in new, high-risk areas of R&D, whose future importance for the partners' technological capabilities remains uncertain for a considerable period of time.

From the results of several studies on the motives for inter-firm partnerships, It becomes apparent that in many cases the cost-economizing and strategic motivations are intertwined. Most studies on R&D partnerships or similar forms of alliances stress a variety of motivations for these relationships (see, Das et al. (1998); Eisenhardt and Schoonhoven (1996); Hagedoorn (1993); Hagedoorn et al. (2000); Lorenzoni and Liarini (1999); Mowery et al. (1996)). The most often discussed motivations (in no particular order) are:

- the need to monitor and engage in the cross-fertilization of technological disciplines,
- the need to achieve economies of scale and scope in R&D,
- the need to share the costs of R&D projects,
- the need to shorten the innovation cycle,
- the desire to incorporate complementary technologies,
- the desire to search for technological synergies,
- the desire to capture a partner's tacit knowledge,
- the desire to jointly manage R&D uncertainty.

Although partnerships are a crucial element in the overall strategy of many companies, for others they are irrelevant, and play only a complementary part in their strategic activities. There is some evidence to indicate that leading companies (market leaders and technology leaders) seek partnerships outside their core activities, searching for new activities and new technological oortunities beyond their current domain (Hagedoorn (1995); Hamel (1991); Hamel and Prahalad (1994). However, in general one can expect that many companies' motives for entering into R&D partnerships frequently have both a cost-economizing background and a strategic intent. Furthermore, it is important to comprehend the dynamic aspect behind this, as the motives of a company with multiple research programs can change over time due to both developments in the company itself, as well as within its environment and the partnership (Harrigan, 1988).

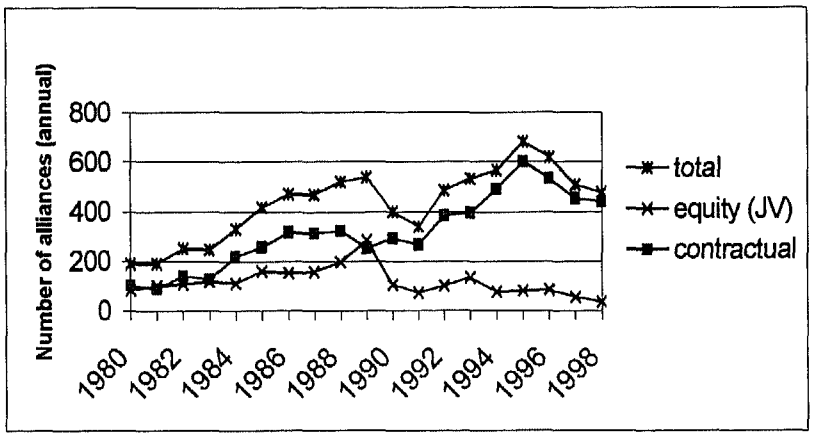
3. GENERAL PATTERNS IN R&D PARTNERSHIPS

Previous empirical research has established that inter-firm partnerships involving all types of cooperative agreements seemed to have flourished during the eighties (Chesnais (1988); Hergert and Morris (1988); Hladik (1985); OECD (1986; 1992)). This general growth pattern also alies to the particular group of partnerships studied in this chapter, that is, R&D partnerships, as shown in Figure 5.1, where the development of strategic alliances over time is charted by plotting the number of strategic alliances

formed in a given year. In addition to the total number of new alliances entered into each year, the other two series represent the number of equity-based joint ventures and contractual alliances.

In fact, the 1980s mark a steep increase from about two hundred partnerships created annually to over five hundred new R&D partnerships each year at the turn of the decade. The first couple of years of the 1990s show a drop in new partnerships, to about three hundred and fifty annually. Yet, another peak is reached in 1995, with a record of nearly seven hundred new R&D partnerships. At the end of the twenty years or so for which data is available in the MERIT-CATI database,[2] the number of new R&D partnerships decreased again, to about five hundred new partnerships per annum. However, this number remains considerably higher than in most years since the early 1980s. One can thus conclude there has been a clear growth pattern in the new R&D partnerships since 1980.

Figure 5.1. Modes of alliances



Possible explanations offered in the literature for this overall growth pattern of new R&D partnerships were discussed in the previous section. They were found to relate to the economic factors forcing companies to collaborate on R&D. Major factors mentioned in this context are linked to industrial and technological changes in the 1980s and 1990s, which led to the increased complexity of scientific and technological development, higher uncertainty surrounding R&D, increasing costs of R&D projects, and shortened innovation cycles that favor collaboration (see Contractor and Lorange

(1988); Hagedoorn (1993; 1996); Mowery (1988); Mytelka (1991); OECD (1992)).

In our discussion of the record to date, we also indicated that previous contributions had already established that during the 1980s the relative share of joint ventures in the total number of partnerships dropped considerably. It appears that contractual forms of partnering, in particular, have become an important instrument of inter-firm collaboration. When looking at the specific trend for R&D partnerships over the past two decades, one arrives at a similar conclusion.

If some small oscillations around an overall trend in Figure 5.1 are ignored, the most striking development is the explosion in contractual forms of alliances over the past 20 years. While in 1980 joint ventures and contractual alliances accounted for roughly half of all annual alliance formation, by 1998 contractual alliances accounted for about 90% of annual alliances. The trend has remained constant since the mid 1990s.

Thus the overall trends in inter-firm R&D partnering indicate two major developments. First, companies, in large measure, increasingly seem to prefer contractual partnerships to joint ventures. Second, that the growth in new R&D partnerships since the early 1980s has broadly been an outcrop of the overwhelming increase in the absolute numbers of contractual partnerships. The explosive growth in contractual alliances will be examined in more detail in the subsequent section with reference to the distribution of alliances across industries and other underlying factors.

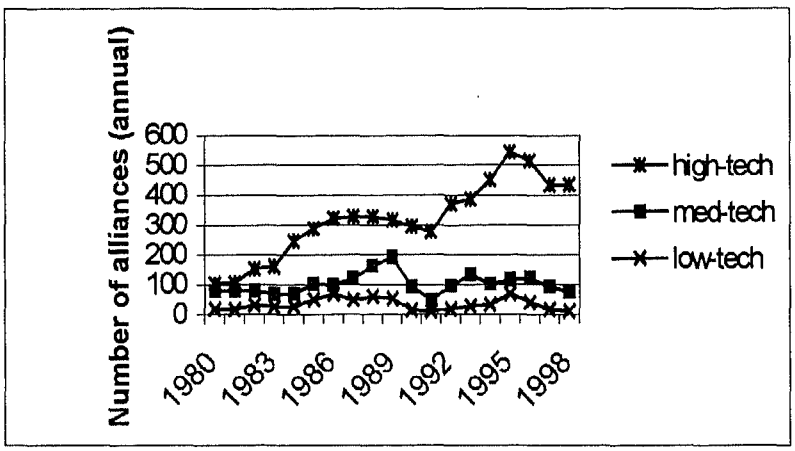
4. SECTORAL PATTERNS IN R&D PARTNERSHIPS

Contributions by, amongst others, Ciborra (1991), Eisenhardt and Schoonhoven (1996), Gomes-Casseres (1996), Harrigan and Newman (1990) and Oster (1992) suggest that inter-firm partnerships are associated with so-called high-technology sectors and other sectors where learning and flexibility are important features of the competitive landscape. In such industries, partnerships enable companies to learn from a variety of partners in a flexible setting of (temporary) alliances across the value chain. Hagedoorn (1993), Link and Bauer (1989) and Mytelka (1991) also indicate that many of these partnerships are concentrated in a limited number of mainly R&D intensive industries.

Since this chapter is concerned with the patterns of R&D partnerships, we would expect that, given the asymmetrical distribution of R&D efforts across industries, the R&D partnerships would also be concentrated in specific industries. In particular, increased partnering in R&D-intensive industries

should naturally ensue. For the purposes of this analysis we follow the OECD (1997) classification of sectoral R&D intensities, as measured by the share of total R&D expenses in total turnover. Accordingly, pharmaceuticals (including biotechnology), information technology and aerospace and defense are classified as high-technology sectors with R&D intensities between 10% and 15%. Instrumentation and medical equipment, automotive, consumer electronics and chemicals are classified as medium-technology industries with R&D intensities ranging between 3% and about 5%, while industries such as food and beverages, metals, oil and gas are classified as low-technology with an R&D intensity of below 1%.

Figure 5.2. Sectoral distribution of alliances



The 1980s and 1990s mark a period where the growth in R&D intensive industries, influenced by biotechnology and a range of information technologies, is reflected in the rising importance of these industries in R&D partnering. In Figure 5.2, the annual number of new alliances is divided into high, medium, and low-technology sectors. It can be observed that from 1980 to 1998 the share of high-technology industries in all newly established R&D partnerships grew from about 50% to over 80%. During the same period the share of medium-technology industries in these new R&D partnerships decreased sharply from about 40% to less than 20%. Thus, in addition to contributing to the explosive growth of contractual forms of alliances, high-

technology alliances account for the vast majority of newly formed alliances over the past ten years.

5. INTERNATIONAL PATTERNS IN R&D PARTNERSHIPS

In many contributions to management literature (de Woot (1990); Ohmae (1990); Osborn and Baughn (1990); Yoshino and Rangan (1995)) and international business literature (Auster (1987); Contractor and Lorange (1988); Dunning (1993); Duysters and Hagedoorn (1996); Hagedoorn and Narula (1996); Mowery (1988); Mytelka (1991)) international partnerships or alliances are considered an important element in the international strategies of a growing number of companies. The basic argument in most of these contributions is that increased international competition forces companies to pursue international strategies. Through these international strategies companies do not only seek foreign market entry but they also seek access to foreign assets (both of a tangible and intangible nature). They thus create international inter-firm partnerships for the international sourcing of R&D, as well as for international production and supply (see e.g., Dunning and Lundan (1998)).

From a traditional transaction cost economics perspective (Williamson (1996)), one would expect companies to be somewhat hesitant to enter into R&D partnerships with foreign companies due to the lack of control over long distances, a possible lack of trust between companies from different countries, and the high asset specificity of R&D. However, as increased international competition has led many companies to follow a strategy of gradual internationalisation, one could also assume that accumulated experience in foreign markets would also tend to a gradual opening to non-domestic R&D partnerships (Hagedoorn and Narula, 1996). Consequently, one would expect that, in the context of the overall importance of internationalisation to companies, the share of international R&D partnerships in the total number of R&D partnerships should have increased as well in the last two decades.

In Figure 5.3, the top line represents the total number of annually alliances, while the other two series included in the figure represent the number of domestic and international alliances respectively. Somewhat contrary to expectation, the internationalisation trend seems to demonstrate a gradual downturn from about 70% in the early 1980s to about 60% of all alliances in the early 1990's. In fact, the late 1990s end with a below 50% share of international partnerships in all new R&D partnerships. Remarkably this

share in the total number of new alliances is more than twice as high as in 1980.[3]

Figure 5.3. International alliances

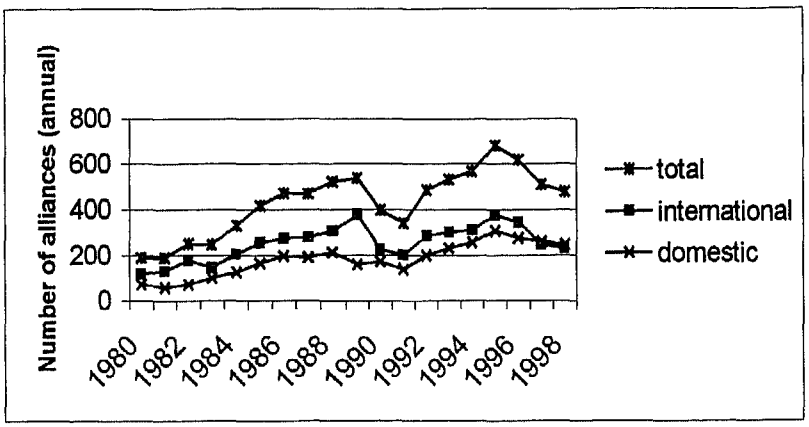


Table 5.1. Total counts and proportional share of different alliance types 1980-1998

	international	domestic	Total	equity (JV)	contractual	Total
high-tech	3336	2728	6064	1158	4908	6066
	55%	*45%*	*100%*	*19%*	*81%*	*100%*
med-tech	1290	643	1933	930	1003	1933
	67%	*33%*	*100%*	*48%*	*52%*	*100%*
low-tech	357	296	653	250	404	654
	55%	*45%*	*100%*	*38%*	*62%*	*100%*
Total	4983	3667	8650	2338	6315	8653

Source: MERIT-CATI database

Out of all the alliances entered into from 1980 to 1998 (in a total count of 8650), 70% are high-technology alliances, and out of the high-technology alliances, 81% are contractual alliances. By examining the proportional share shown in Table 5.1., one finds that, while in absolute terms high-technology alliances are much more prevalent than medium or low-technology alliances, the share of international alliances is highest for medium technology, and to a lesser extent, high technology categories, while

the share of contractual agreements is overwhelmingly dominant in high-technology alliances.

6. CONCLUSIONS

Two trends in the international forms of partnering are readily aarent from our analysis. On the one hand, there is a clear shift whereby companies seem to prefer contractual partnerships to joint ventures, and an explosion in high-technology partnerships, which is expounded in the observed growth in high-technology contractual partnering activity. On the other hand, the trend in increasing international alliances seems to have changed. International alliances presently account for slightly less than half of all new partnering activity (even though the annual number of new alliances has doubled).

However, these aggregate trends mask a great deal of inter-industry variation, since the information technology and chemicals sectors alone account for slightly under and slightly over half of all new alliances in the high and medium-technology sectors respectively. Thus in seeking to expose the contemporary patterns of R&D partnering, a large part of the explanation arises from the behavior of the 'representative firm', which at end of the 1990s is an American information technology company that forms a contractual alliance with a domestic (or international) competitor.

Any industry-specific developments aside, the overall growth in partnering activity is related to the internationalisation process of firms within the Triad, and 'second generation' thinking concerning the value of knowledge-intensive assets outside the firm, whether located domestically or abroad. While in the earlier stages of internationalisation, firms tend to keep their R&D-related activities closer to home, the increased partnering activity is an outgrowth of the internationalisation of the R&D function, which has also resulted in the establishment of corporate R&D centres abroad. While equity-based forms of collaboration will still be preferred in some instances, the extent of foreign sourcing of knowledge-based assets in highly competitive industries is such that only contractual modes can often be considered cost-effective.

NOTES

1. It is recognised that to an extent, all contracts are incomplete, and achieve their completeness from the institutions that are involved in their enforcement, including the social capital existing between the parties.

2. The composition of the MERIT-CATI database has been discussed extensively, see for example, Hagedoorn and Narula (1996).
3. While our investigation is not strictly limited to the Triad countries, in practice 95% of all R&D partnerships within the database occur within the Triad of the United States, Europe and Japan (Narula and Hagedoorn (1999)).

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